

## II.4-RES-SNGL-A-INDSRCHGE SINGLE RESERVOIR REGULATION OPERATION SCHEME INDUCED SURCHARGE

### Description

Scheme INDSRCHGE is used during flood situations to provide additional storage above normal top of pool level.

Many reservoirs are operated in the induced surcharge mode of operation during flood periods. In this mode all spillway gates are raised uniformly to permit water to flow between the spillway crest and the bottom of the spillway gates. This permits the reduction of peak discharge from the dam by using reservoir storage above the normal elevation of the top of gates.

The induced surcharge curves are developed from past floods by the agency operating the dam. The curves show a relationship between pool elevation, mean inflow for a specified previous time unit and outflow for the next time step. The curves are applicable only during periods when the pool elevation is rising. When the elevation starts to fall other relations are used to evacuate the induced-surcharge storage.

Separate induced surcharge curves and evacuation instructions may be used for winter and summer. In this case two sets of surcharge curves and two sets of evacuation instructions will have to be input.

When the pool starts to fall a variety of instructions are used. Generally the first step is to keep the same gate openings at maximum pool (or keep the same maximum outflow) until the storage is evacuated to a designated pool elevation (or rule curve elevation). If further evacuation is needed additional instructions are used to bring the pool down to normal level.

Outflows from keeping the same gate settings can be determined by means of a three-way relation between pool elevation, gate openings and total discharge (including generation or sluice discharge). Gate openings are assumed to be the same for all gates.

Ten evacuation options are provided in the Scheme. The evacuation option used will be dependent on one of the following conditions:

1. Pool elevation
2. Peak outflow
3. Peak pool elevation
4. Pool elevation and peak outflow
5. Peak outflow and peak pool elevation

A decision table (input by the user) based on exceedance criteria of the selected condition will determine which of the following evacuation options will be in effect:

1. The maximum gate setting is maintained until the pool drops to a specified or rule curve elevation (or rule curve plus a specified addition).
2. The maximum outflow is maintained until the pool drops to a specified or rule curve elevation (or rule curve plus a specified addition).
3.
  - a. The maximum gate setting is maintained until the inflow is specified amount less than the outflow.
  - b. The outflow is then reduced at a specified rate per time step until outflow reaches a specified value, the pool drops to a specified elevation or inflow drops to a specified amount less than outflow. Outflow cannot be reduced to less than inflow or inflow plus a specified addition. If outflow reaches the specified value before the specified (or rule curve) elevation is reached the specified discharge is used until the specified elevation is reached.
4.
  - a. The maximum outflow is maintained until the outflow is a specified amount greater than the inflow.
  - b. Same as 3b.
5. Option 5 is a combination of options 1 and 3b.
6. Option 6 is a combination of options 2 and 3b.
7. Option 4 is the same as option 3b.
8. Outflow is reduced to a specified discharge or to inflow plus a specified addition (whichever is greater). After outflow drops to the specified discharge option 3b is used.
9. Option 9 is a combination of options 1 and 8.
10. Option 10 is a combination of options 2 and 8.

An example of evacuation instructions and decision table for George Reservoir is at the end of this document. The required is also attached. In this example the option is dependent on the peak outflow and the peak pool elevation.

#### Parameters

Following are additional parameters needed for the Scheme. A complete set of parameters are needed for both seasonal instructions if two are required:

(HUPPER) - Limiting upper elevation above which the operation is always in induced surcharge

- (HCHECK) - Curve checking elevation
- (HLOWER) - Limiting lower elevation
- (COMPINQ) - Time interval for computing mean inflows used in surcharge relation

Following three define the 3-way induced surcharge relation

- (SCQI) - Inflow values for surcharge curve
- (SCEL) - Elevation values for surcharge curve
- (SCQO) - Discharge values for surcharge curve
- (CONV) - Iteration convergence criterion for determining induced surcharge release
- (DTYPE) - Flag for type of decision table
- (DTABL) - Decision table for specifying evacuation options Pool elevations, peak outflows or peak pool elevations are used in the table either alone or in the combinations given in the description

The following parameters may be needed depending on the options chosen in DTABL:

- (HTARGETI) - Target elevation
- (DIFFQI1) - Inflow difference number one
- (REDUCE) - Rate per time step for reducing outflow
- (QTARGET1) - Target discharge number one
- (QTARGET2) - Target discharge number two
- (DIFFQI2) - Inflow difference number two
- (DIFFQI3) - Inflow difference number three

Following 3 parameters define the 3-way relationship for gates:

- (GATEOPEN) - Gate openings (same for all gates)
- (GATEL) - Pool elevations
- (GATEQ) - Total discharge (including generation or sluice discharge)
- (GATESET) - Time interval for resetting gates - this is not necessarily the same as for computing mean inflows
- (IOPTND) - Flag to indicate whether gate opening is reduced for rising pool

- (CURVE) - Rule Curve
- (RULETIME) - Time of day rulecurve is set

#### Time Series

No time series are needed.

#### Carryover

- (BACKQ1) - Instantaneous inflow 2 period prior to start of run
- (BACKPOOL) - Pool elevation 2 periods prior to start of run
- (TENDENCY) - Change in pool elevation during the last computational step in the time interval previous to the initial time interval
- (MAXEL) - Maximum elevation for a surcharge operation
- (QMAXEL) - Discharge of elevation MAXEL
- (MAXQ) - Maximum outflow for a surcharge operation

**Decision Table For Evacuation Options**

George Reservoir (December through April)

<u>Peak Outflow</u>	<u>Peak Pool</u>	<u>Evacuation Option</u>
>0	0	3
>0	187	3
>65,000	0	8
>65,000	187	9

**Excerpt from George Reservoir Operating Manual**

Proposed flood regulation schedule for George Reservoir

I. December through April

- a. If the reservoir is below elevation 185 continue normal power operations until pool reaches 185 then operate according to the induced surcharge schedule. Follow induced surcharge schedule until pool peaks then follow emptying instructions in II below. Do not let pool rise above 185 except when operating according to the induced surcharge schedule unless previously authorized by the Reservoir Regulation Section.
- b. If the reservoir is above elevation 185 operate according to the induced surcharge schedule. Follow induced surcharge schedule until pool peaks then follow emptying instructions in II below.

II. Emptying Instructions

<u>Peak Outflow</u>	<u>Peak Pool</u>	<u>Applicable Instruction</u>
Greater than 65,000 CFS	Elevation 187 or greater	A
Greater than 65,000 CFS	Less than elevation 187	B
Less than 65,000 CFS		D

Instructions

- A. Maintain gate setting required for peak outflow until pool recedes the elevation 187 then follow instructions in B.
- B. Reduce outflow to 65,000 CFS or to inflow plus 10,000 CFS whichever is greater. If this results in outflow greater than 65,000 CFS continue passing inflow plus 10,000 CFS until

outflow reaches 6,000 CFS then follow instructions in C.

- C. Reduce outflow at rate of 1,000 CFS per hour until outflow reaches 30,000 CFS or pool recedes to elevation 185. (In applying this rule do not reduce outflow to less than the inflow). If outflow reaches 30,000 CFS before pool reaches elevation 185 continue to discharge 30,000 CFS until pool is lowered to elevation 185. When elevation 185 is reached revert to normal power operations.
- D. Maintain gate setting required for peak outflow until inflow is 5,000 CFS less than outflow then following instructions in C.

After emptying operation commences if the inflow increases sufficiently to exceed the outflow follow instructions in Ib above.